Task 1:

Student 6

Evidence Record

Height (cm)	Diameter of drop 1 (mm)	Diameter of drop 2 (mm)	Diameter of drop 3 (mm)	Average Diameter of drops	Shape and General Observations of Blood Spatters
10	110	14	40	29.3	circular
20	32	28	25	28.3	splatter
30	20	10	13	14.3	big &
40	20	10	20	16.6	small
50	50	26	33	36.3	spread
60	13	15	14	14	out
80	15	17	30	20.6	
100	11	12	15	12.6	
120	18	10	15	14.3	
140	18	19	20	19	
160	15	20	15	16.6	
180	11	15	16	14	
200	19	19	18	18.6	
Crime Scene					

Introduction:

Mrs. Dickerson and Mr. Johnson have been found dead. It is clear that they were both murdered with math supplies found in TCHS. Two different blood types were found at the scene along with blood on the victim's knuckles suggesting their attacker(s) must have been struck by his or her victims in a struggle. The small volume of blood reveals the wound was minor and would have healed by this point. The suspects in question are all 27 students in Mrs. Holder's 4th Block Integrated Math class. The task ahead is to narrow down the height of the killer by determining the minimum height of our killer using the blood spatter evidence.

r^2 value for linear fit (rounded to nearest ten-thousandth) __.1506__

r^2 value for natural logarithm fit __.1750__

r^2 value for quadratic fit __.1971__

r2 value for power curve fit __.1970__

Type of curve that gives best fit of data : __quadratic__

Equation for the best fit Y= _____

Calculated height of splatters from crime scene X : _____

Part 1: Create Blood Spatters from Known Heights

1. Spread newspaper on the ground. Place a white paper on the newspaper.
2. Fill a pipette with simulated blood.
3. From the height of 10cm, drop 3 blood drops onto different spots on the white piece of paper.
4. Repeat for all heights indicated on the Evidence Record.
5. Let all blood drops dry at least 5 minutes before continuing.
6. Using a ruler, measure the diameter of each drop.
7. Record the 3 diameters in the Evidence Record.
8. Calculate the average diameter of the blood spatters for each individual height and record it.

Case Analysis

1 Which type of curve gave the best fit to your data?

2 Did the shape of the blood spatters change as the height increased? Explain.
   The space became more uneven as height increased

3 Which of the suspects could have created the blood spatters at the crime scene? Explain.

4 How accurate do you think your height estimate is? What factors can contribute to inaccuracy in your estimate? How can you reduce the errors from these factors?

5 Not very. how much, the circumstances, the person

Forensic Scientists often do tests to determine the relationship between height and splatter diameter for the different cases they are involved in. What factors can cause the relationship between heights and splatter to differ from crime scene to crime scene?

Task 2:

Modeling with functions

1. Greg builds model trains. He gathered data on the amount of paint needed to create model trains of different sizes. Using the information below, use an appropriate regression model to estimate the amount of paint needed to create a 10-foot-long model train.

Model train length (ft.)	Paint needed (oz.)
1	3
2	7
3	15
5	41

a. Enter the data in your calculator and choose a regression model (linear, cubic, ~~exponential~~, quadratic).

b. Apply the regression model and note your function.

about 2047 oz. $-1 + 2x^{+1}$

c. Why did you choose this regression model? Provide mathematical reasoning to justify your choice.

The graph has an exponential curve. I used guess and check.

2. The graph below shows average height (in.) for female youth in Ireland.

$\frac{40}{20} = 2$
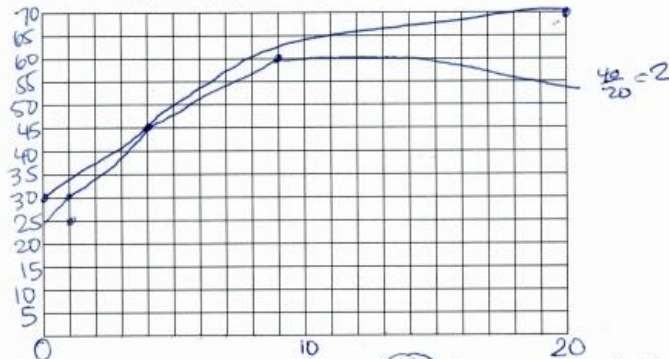
a. Use the graph and calculator to choose a regression model (~~linear~~, cubic, exponential, quadratic).

b. Apply the regression model and note your function.

$2x + 30$ or   Square root $20 + 9\sqrt{x}$

c. Use your function from part b to predict the height of a nine-year-old girl.

48 in.   47 in

d. Using your answer above how does you predict value from the model compare to the graph?

My predicted value in c is very close to what both graphs read.

e. Why did you choose this regression model? Provide mathematical reasoning to justify your choice.

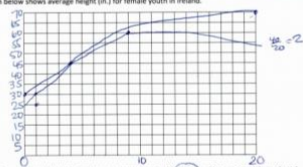My square root graph accurately shows average heights of girls aged 0-20.

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Task 3:

Match each definition to its corresponding term.

1. Outlier — a. A value found by Q3 + (IQR x 1.5)
2. Lower fence — b. A value found by Q3 – (IQR x 1.5)
3. Interquartile range — c. A value found by Q3 – Q1
4. Upper fence — d. A data value that is significantly greater or less than the other values in a data set

Calculate the IQR of each given data set. Determine whether there are any outliers in each set and list them.

5. The data are 2, 3, 5, 5, 6, 9, 35

Q1 = 3, Q3 = 9　　Lower Fence:　　　　　　Upper Fence:

IQR = Q3 – Q1　　Q1 – (IQR x 1.5) = 3 – (6 x 1.5)　　Q3 + (IQR x 1.5) = 9 + (6 x 1.5)

　= 9 - 3　　　　　= 3 - 9　　　　　　　= 9 + 9

　= 6　　　　　　= -6　　　　　　　= 18

The value 35 is an outlier because it is greater than the upper fence.

6. The data are 8, 9, 10, 12, 14, ⑭, 18, 23, 24, 25, 35

$Q1 = 10$　$Q3 = 24$　lower　upper

$IQR = 24 - 10$　$Q1 - (IQR \times 1.5)$　$Q3 + (IQR \times 1.5)$

　　14　　　$10 - (14 \times 1.5)$　$24 + (14 \times 1.5)$

　　　　　　$10 - 21$　　$24 + 21$

　　　　　　-11　　　45　no outliers

7.

min　　Q1　　　　　Q3　　max

2　2.5　3　3.5　4　4.5　5　5.5　⑥　6.5　7　7.5　8
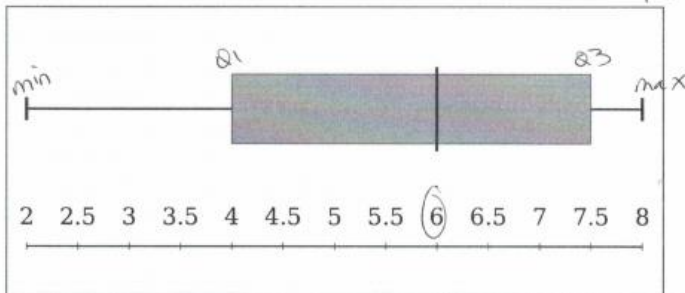
$Q1 = 4$　　lower = $4 - (3.5 \times 1.5) = -1.25$
$Q3 = 7.5$　　upper = $7.5 + (3.5 \times 1.5) = 12.75$
med = 6
$IQR = 3.5$　　　12.75 is the outlier

Calculate the IQR of each given data set. Determine whether there are any outliers in each set and list them.

8.

4　6　8　10　12　14　16　18　20　22　24
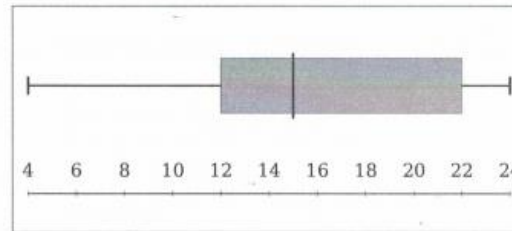
$Q1 = 12$
$Q3 = 22$
$IQR = 10$

lower $12 - (10 \times 1.5) = -3$

upper $22 + (10.15) = 37$
37 is the outlier

Use data below to answer the following questions.

9. The table shows the average monthly precipitation in centimeters during the winter for certain states.

State	Average Monthly Precipitation (cm)
New York	123
Rhode Island	67
Pennsylvania	25
New Jersey	77
California	12
Florida	56
Nebraska	107
Minnesota	45
North Dakota	21

a. Find the five number summary.

mean = 59.5
min = 12
$Q1 = 23$
med = 56
$Q3 = 92$　max = 123

b. Determine whether or not there are any outliers. Show your work.

$92 - 23 = 69$　　$23 - (69 \times 1.5) = -80.5$
　　　　　$92 + (69 \times 1.5) = 195.5$

c. Construct a box and whisker plot to show any outliers.

10　　40　　70　　140

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Module 1: Section 1D: A Closer Look at the Standards for Mathematical Content: High School Statistics & Probability Sample Tasks

Participant Guide
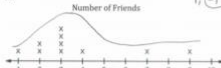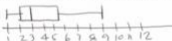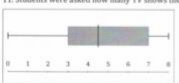
Student Work Sample	Standard of Mathematical Content Focus	Degree of Alignment	Standards of Mathematical Practice (SMP) Focus
Sample Task 1: 	Can you identify the targeted content standard(s) for this task?	• None/Weak • Partial • Strong	Can you identify the targeted practice standard(s) for this task?

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Student Work Sample	Standard of Mathematical Content Focus	Degree of Alignment	Standards of Mathematical Practice (SMP) Focus
Sample Task 2: 	Can you identify the targeted content standard(s) for this task?	• None/Weak • Partial • Strong	Can you identify the targeted practice standard(s) for this task?

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Student Work Sample	Standard of Mathematical Content Focus	Degree of Alignment	Standards of Mathematical Practice (SMP) Focus
Sample Task 3:	Can you identify the targeted content standard(s) for this task?	• None/Weak • Partial • Strong	Can you identify the targeted practice standard(s) for this task?

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Module 1: Section 1D: A Closer Look at the Standards for Mathematical Content: High School Statistics & Probability Sample Tasks

Facilitator's Guide

Throughout facilitation of this activity it will be important to remind participants:
- Use the grade-level overview to determine the relevant cluster(s) to look at more closely
- Questions regarding Standards for Mathematical Practices will only be indicated where specific practices were identified within the source of the task alignment. Additionally, emphasize to participants the statement at the end of each cluster within the *KAS for Mathematics*, "The identified mathematical practices, coherence connections, and clarifications are possible suggestions; however, they are not the only pathways."

Sample Task 1:
This assignment is strongly aligned to the standards.

OVERVIEW
High school students explain why a linear model is most appropriate for a given data set and then answer questions about the situation and the math involved. They are then exposed to a second context through a residual plot where a linear model is not appropriate, and they need to explain how they know given the residuals. The assignment is strongly aligned to the standard because it requires students to fit a model to data, assess the fit of the model by analyzing residuals, and solve problems in the context of the data.

RELATED STANDARDS
We looked at how well the assignment aligned to the following standard:

KY.HS.SP.6 Represent data on two quantitative variables on a scatter plot and describe how the explanatory and response variables are related.
a.   Calculate an appropriate mathematical model, or use a given mathematical model, for data to solve problems in context.
b.   Informally assess the fit of a model (through calculating correlation for linear data, plotting, calculating and/or analyzing residuals)

WHY IS THIS ASSIGNMENT STRONGLY ALIGNED?
In eighth grade, students first work with bivariate data (measurement data on two related variables). They create scatter plots, find linear equations that best fit the data, and use their equations to answer real-world questions. These concepts are extended in high school when students work with bivariate data that might have a non-linear relationship. This assignment allows students to work with bivariate data in a manner appropriate for high school.

Please note that inclusion of these sample tasks does not represent that this task is endorsed by or rejected by the Kentucky Department of Education. Inclusion of these tasks was for the sole purpose of allowing participants the opportunity to investigate the content standards within the *Kentucky Academic Standards for Mathematics* more closely. All tasks were selected from https://tntp.org/student-work-library.

The assignment appropriately allows students to build their conceptual understanding by asking them to use functions fitted to data to solve problems in the context of the data and informally assess the fit of a function by analyzing residuals (all aligned with standard KY.HS.SP.6).

Practice Standards

The assignment gives students a strong opportunity to engage with Mathematical Practice Standard #4 ("Model with mathematics"), which suggests that students "apply the mathematics they know to solve problems arising in everyday life, society, and the workplace." In this task, students are asked to use a function to describe how one quantity of interest depends on another in an authentic, if simulated, context. The assignment also allows students to engage with Mathematical Practice Standard #2 ("Reason abstractly and quantitatively") by asking questions that require them to fluently move from the decontextualized symbolic representation of the situation to the contextualized situation where they pay attention to the meaning of the quantities.

Sample Task 2:

This assignment is partially aligned to the standards.

OVERVIEW

High school students find the regression models that best represent the data provided and answer questions about the real-world situations they model. The assignment is partially aligned to the standards because it requires students to use technology to test and analyze different models, but it doesn't provide the opportunity for students to represent the data on a scatterplot, describe how the variables are related, or to plot and analyze residuals.

RELATED STANDARDS

We looked at how well the assignment aligned to the following standard:

KY.HS.SP.6: Represent data on two quantitative variables on a scatter plot and describe how the explanatory and response variables are related.

KY.HS.SP.6.a: Calculate an appropriate mathematical model, or use a given mathematical model, for data to solve problems in context.

KY.HS.SP.6.b: Informally assess the fit of a model (through calculating correlation for linear data, plotting, calculating and/or analyzing residuals).

WHY IS THIS ASSIGNMENT PARTIALLY ALIGNED?

The assignment involves mathematical models appropriate to high school (linear, quadratic, exponential), and in question 2b, allows students to use the model to answer questions about the situation it represents. However, the assignment is only partially aligned with the standard because it does not give students enough opportunity to describe how the explanatory and response variables are related (KY.HS.SP.6), to use models fitted to data to solve problems in the context of the data, or to calculate an appropriate model for the context (KY.HS.SP.6.a). Students could assess the fit of their regression models by plotting, calculating and/or analyzing residuals (KY.HS.SP.6.b), but the structure of the assignment does not encourage them to do so.

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The assignment does allow students to use appropriate procedural skill, such as representing quantitative data on a scatter plot and fitting functions to data. However, students should also be building their conceptual understanding by describing how variables are related, choosing a model suggested by context, and analyzing residuals—and the assignment does not require students to do any of those things.

Practice Standards

The assignment gives students the chance to engage with Mathematical Practice Standard #5 ("Use appropriate tools strategically") by suggesting the use of calculators to test and select regression models for the provided data. To be fully aligned to the standard, however, the assignment should also have given students the chance to engage with Mathematical Practice Standard #7 ("Look for and make use of structure") by asking students to describe how variables are related and assess the fit of a function by plotting and analyzing residuals.

Sample Task 3:

This assignment is weakly aligned to the standards.

OVERVIEW

High school students calculate statistics of given data sets, presented as sets of numbers, box plots, or in a table. The assignment is weakly aligned to the standards because it tells students which statistics to calculate instead of allowing them to determine themselves which statistics are most appropriate. Although students are asked to determine if outliers are present, they do not use this information in the ways required by the standard. Additionally, the assignment doesn't require students to make connections between two or more data sets.

RELATED STANDARDS

We looked at how well the assignment aligned to the following standards:

    KY.HS.SP.1: Represent the distribution of data with plots on the real number line (stem plots, dot plots, histograms and box plots).

    KY.HS.SP.2: Use statistics appropriate to the shape of the numerical data distribution to compare center (median, mean) and spread (interquartile range when comparing medians and standard deviation when comparing means) of different data distributions.

    KY.HS.SP.3 Interpret differences in shape, center and spread in the context of the distributions of the numerical data, accounting for the presence and possible effects of extreme data points (outliers).

Why is this assignment weakly aligned?

This assignment aligns more closely to sixth-grade standards (KY.6.SP.4 and KY.6.SP.5) because of its focus on computing statistics (interquartile range, outliers, five-number summary) for given data sets. There are no options for students to select "the statistics appropriate to the shape of the distribution," or to consider the standard deviation as a measure of variability as required by the high school standards.

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High school students should be using data representations and statistics to compare and interpret differences in two or more data sets, but this assignment only asks students to work with one data set at a time (again, more closely aligned to sixth-grade expectations). Additionally, technology should be leveraged in high school to create displays and to calculate statistics to help students focus on interpretation and comparison, but this assignment does not involve technology.

Practice Standards
The assignment does not provide the opportunity to engage with any mathematical practice standards. Were it more closely aligned to the high school standards, students would have the opportunity to engage with Mathematical Practice Standard #5 ("Use appropriate tools strategically") by using graphing calculators or computer software to create data displays and calculate statistics. Students could also have been given the chance to engage with Mathematical Practice Standard #7 ("Look for and make use of structure") by selecting the "statistics appropriate to the shape of the data distribution."